Magnetic Field Finite-Element Calculations for the SNS Neutron EDM Experiment

S. BALASCUTA, R. ALARCON, Arizona State University, B. FILIPPONE, B. PLASTER, R. SCHMID, California Institute of Technology, NEDM COLLABORATION — The nEDM experiment is a new search for the electric dipole moment (EDM) of the neutron with a sensitivity of $10^{-28}$ e-cm at the recently constructed Spallation Neutron Source (SNS). The measurement requires a static magnetic field surrounding two target cells that contain superfluid $^4$He, polarized neutrons and polarized $^3$He atoms. The latter are used as a co-magnetometer and ultracold neutron spin precession frequency analyzer. The applied static magnetic field, $B_0$, is chosen to be about 10 mG resulting in a precession of the magnetic moments for both neutrons and $^3$He nuclei of $\sim 30$ Hz. To maintain the polarization of the neutrons and $^3$He atoms, the magnetic field should be very uniform with gradients of the order of 0.1 $\mu$G/cm averaged over each cell volume. A separate requirement on the volume-averaged magnetic field gradient $\langle dB_x/dx \rangle$ in the direction of $B_0$ of less than 0.01 $\mu$G/cm is necessary to minimize false EDM signals. In addition, to reduce the influence of ambient external fields an overall magnetic shielding factor of $\sim 10^5$ is required. We present finite-element calculation results for the complete nEDM static magnetic field configuration including magnetic field gradients and $^3$He relaxation rates.